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## Changes in Body Weight After Total Hip Arthroplasty: Short-term and Long-term Effects

Nienke Paans, Martin Stevens, Robert Wagenmakers, Jan van Beveren, Klaas van der Meer, Sjoerd K. Bulstra, Inge van den Akker-Scheek

**Background.** Elevated body weight is associated with hip osteoarthritis (OA) and subsequently with total hip arthroplasty (THA). Patients with hip OA who are overweight often mention their restricted mobility as a factor that thwarts their attempts to be physically active and lose weight. There is some evidence that THA increases physical activity, but none for losing body weight after THA.

**Objective.** The purpose of this study was to analyze the short-term (1-year) and long-term (4.5-year) effects of a THA on body weight.

**Design.** This was an observational, multicenter cohort study.

**Methods.** For the short-term effect, all patients (N=618) were analyzed; for the long-term effect, a random subgroup (n=100) was analyzed. Preoperative and postoperative body weight and height were self-reported. Patients were categorized according to their preoperative body mass index (BMI <25 kg/m<sup>2</sup>=normal weight, 25–30 kg/m<sup>2</sup>=overweight, >30 kg/m<sup>2</sup>=obese). Clinical relevancy was set at a minimum of 5% weight loss compared with baseline.

**Results.** The mean age of the study group was 70 years (SD=8), 74% were women, and mean preoperative body mass was 79 kg (SD=14). One year after THA, a significant decrease in body weight of 1% and 3.4% occurred for the overweight and obese BMI categories, respectively. After 4.5 years, a significant decrease in body weight of 6.4% occurred for the obese BMI category.

**Limitations.** Height and weight—and thus BMI—were self-reported.

**Conclusion.** Patients in the overweight and obese groups showed a decrease, albeit not clinically relevant, in body weight after 1 year. After 4.5 years, a decrease that was relevant clinically was observed in the patients who were obese. It can be concluded that no clinically relevant reduction of weight occurred after THA, except in the long term for patients who were obese.



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Osteoarthritis (OA) of the hip is one of the most prevalent age-related chronic conditions.<sup>1,2</sup> It causes a significant impairment in patients' mobility and has a high impact on quality of life.<sup>3</sup> Total hip arthroplasty (THA) has become known as a highly successful treatment for advanced OA. The incidence of patients with hip OA who need a hip arthroplasty is growing. The yearly numbers of hip arthroplasty interventions in the Netherlands for 1995–2005 increased from 13,785 to 20,715—almost 50%. A need for 51,000 hip prostheses per year is expected by the year 2030.<sup>4</sup> One explanation for this increase is that in Western societies, including the Netherlands, older adults are growing in number as well as in age.<sup>5</sup> Another explanation for the increase in the need for hip prostheses is the growing number of patients who are overweight,<sup>6–8</sup> as a high BMI is considered a risk factor in the development of OA.<sup>9</sup>

Patients who are overweight and awaiting hip arthroplasty are advised strongly to lose body weight in advance by increasing physical activity or through nutritional change. An important reason for losing weight is to increase the chance of surgical success by lowering infection rates and reducing problems of wound-tissue healing.<sup>10,11</sup> However, most patients report being unable to lose weight because of physical limitations and pain. Because the hip arthroplasty is supposed to diminish pain and increase mobility, patients assume weight loss will occur naturally after their surgery.<sup>12</sup>

Losing weight after hip arthroplasty is no less important. A high BMI after hip arthroplasty surgery has implications for implant stability, with a 6-fold higher risk for implant dislocation compared with a low BMI.<sup>13,14</sup> In addition, Roder et al<sup>15</sup> showed that each extra unit of BMI increases

stem-loosening odds. Finally, it is known that a high BMI can affect polyethylene wear negatively, which in turn has a negative effect on implant longevity.<sup>16</sup> With respect to general health, overweight or obesity is considered a risk factor for all kinds of serious illnesses, such as type 2 diabetes and coronary heart disease,<sup>17</sup> which is another reason for losing weight after a THA.

From the small number of studies presenting change of body weight in patients with hip OA who were overweight, it can be concluded that these patients do not lose weight after hip arthroplasty; some of these studies presented no change, and some showed an increase in body weight. However, there are some points of criticism that can be raised with respect to these past studies, including the fact that some studies used no BMI categories (normal weight, overweight, or obese)<sup>18,19</sup>; that patients were recruited from one source (eg, university or regional hospital), which might have consequences for the generalizability of results<sup>12,18–21</sup>; that some studies did not consider the influence of comorbidities or presurgical fitness status (American Society of Anesthesiologists [ASA] status) in their analyses<sup>12,18,19,21</sup>; and that the effect was determined only 1 year after THA.<sup>18,20</sup> The objective of this study, therefore, was to analyze the short-term and long-term effects of THA on body weight, taking into account the aforementioned points of criticism.

## Method

### Design and Setting

An observational, multicenter cohort study was conducted at the University Medical Center in Groningen (university hospital), Martini Hospital in Groningen (large teaching hospital), and Röpcke-Zweers Hospital in Hardenberg (regional hospital). All hospitals are situated in the north-

ern part of the Netherlands. Recruitment for the study started in 2005, and the last data were collected in 2010.

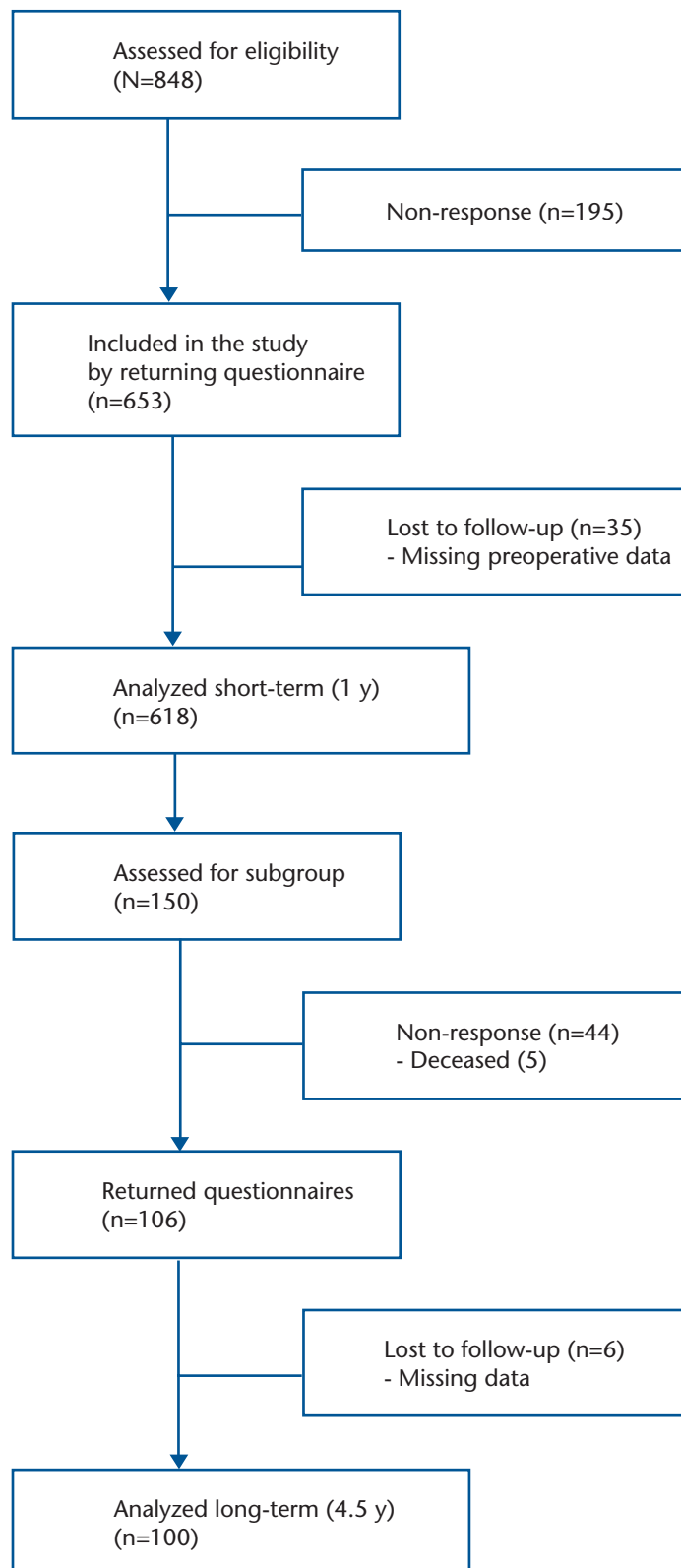
### Data Collection

Patients' sex, age at surgery, self-reported height, self-reported body weight, and ASA status were recorded from their medical records. The ASA status is a standard measure of fitness for surgery, scored in this study as 1 (normal, healthy), 2 (mild systemic disease), or 3 (severe systemic disease).<sup>22</sup> Postoperative self-reported body mass was obtained through questionnaires, with a mean of 1 year (short-term) and 4.5 years (long-term) postoperatively. These questionnaires also asked whether the patients had had other knee or hip surgery in the follow-up period.

### Selection Criteria

Patients admitted to the orthopedic surgery department in 2005 and 2006 for an elective THA because of primary hip OA were eligible for the study (N=848) and invited to participate by a questionnaire sent 1 year after surgery (short-term effect). A total of 653 patients returned the questionnaire, and their medical records were assembled to collect body weight and height at the time of surgery. A flowchart of the study population is presented in Figure 1.

To get an impression of the long-term effect, approximately 20% of the 1-year follow-up group was selected at random. In this draw, the different ratios related to the origin of the patients from the 3 different hospitals were taken into account. In addition, a non-response of 20% was taken into account, which eventually resulted in 150 patients who were sent a questionnaire for the second time.



**Figure 1.**  
Flowchart of the study population.

### Height, Body Weight, and Body Mass Index

Preoperative height and body weight from the medical records, as well as the postoperative data, were self-reported. Preoperative BMI was calculated by dividing body weight in kilograms by height in square meters. For preoperative BMI, the patients were divided into BMI categories defined as normal weight (BMI <25 kg/m<sup>2</sup>), overweight (BMI between 25 and 30 kg/m<sup>2</sup>), and obese (BMI >30 kg/m<sup>2</sup>).<sup>23</sup>

### Body Weight Change

Body weight change was measured per BMI category and considered clinically significant if the loss or gain was at least 5% of the preoperative weight.<sup>24</sup> This minimum amount of weight loss is required to induce metabolic and cardiovascular health benefits.<sup>25</sup>

### Data Analysis

Descriptive statistics were used to describe the study sample. The baseline characteristics of the short-term follow-up group and the long-term follow-up group were compared for differences using chi-square and independent *t*-test analyses. Generalized estimating equations (GEEs) were used to investigate the time course of body weight in the patients who had a THA at baseline.<sup>26</sup> The GEE adjusts for the correlation between repeated observations taken from the same individual and is able to handle longitudinal data on participants with a varying number of unequally spaced observations. An exchangeable correlation structure was assumed in all analyses. All statistical analyses were performed with PASW Statistics 18 (SPSS Inc, Chicago, Illinois). A significance level of *P*<.05 was considered statistically significant. For effect modification analysis, the variables sex, age at time of surgery, other knee or hip surgery, and ASA status were taken into account, and a

significance level of  $P < .01$  was considered statistically significant.

## Results

A total of 653 patients (77%) returned the questionnaire 1 year after surgery. The response rates for the 3 hospitals were 61% (university hospital), 74% (large teaching hospital), and 95% (regional hospital). In 35 medical records, preoperative weight or height could not be found. As a result, 618 patients were included in the 1-year follow-up. In the 5-year follow-up group, 106 patients (71%) returned the questionnaire. The response rates for the three hospitals were 60% (university hospital), 81% (large teaching hospital), and 73% (regional hospital). For 6 patients, data were incomplete, which led to the inclusion of 100 patients. The mean follow-up time of the long-term follow-up group was 4.5 years.

## Demographic Characteristics

The Table shows the demographic characteristics and the BMI and ASA classification of the short-term (1-year) and long-term (4.5-year) follow-up groups at baseline. In both groups, most patients were overweight and had mild systemic disease at the time of surgery.

The representativeness of this long-term follow-up group also was analyzed. To that end, the demographic characteristics and baseline BMI and ASA scores of the short-term and long-term follow-up groups were compared.

## Short-term Effect of THA on Body Weight

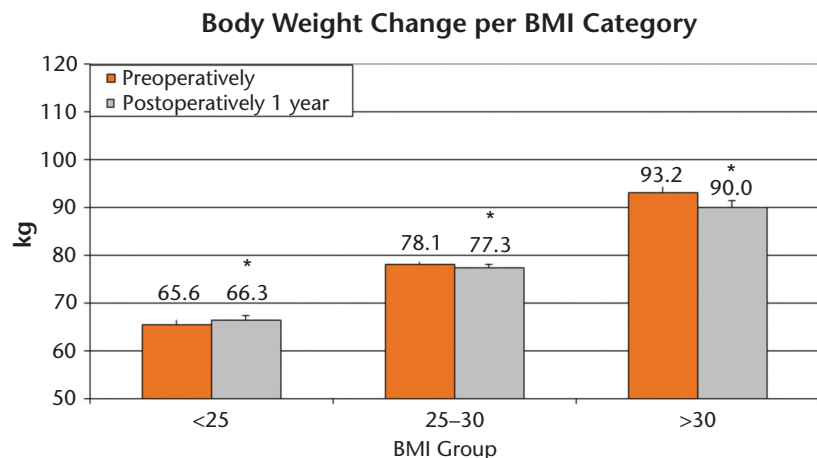
In Figure 2 the mean ( $\pm$ standard error) body weight of patients is shown per BMI category preoperatively and 1 year postoperatively. The GEE analysis showed a significant increase in body weight of 0.7 kg in the group with normal weight (95% confidence interval

**Table.**

Demographics (Preoperatively)<sup>a</sup>

Measure	Short-term (1-y) Follow-up Group (n=618)	Long-term (4.5-y) Follow-up Group (n=100)
Age (y)	70.2 (8.2)	70.7 (8.1)
Sex (n/% female)	458/74.1	72/72.0
Height (m)	168.1 (9.2)	168.9 (7.6)
Body weight (kg)	78.6 (14.0)	81.2 (16.4)
BMI category (n/%)		
<25 kg/m <sup>2</sup>	162/26.2	24/24.0
25–30 kg/m <sup>2</sup>	294/47.6	46/46.0
>30 kg/m <sup>2</sup>	162/26.2	30/30.0
ASA physical status (n/%)		
1	172/27.8	33/33.0
2	398/64.4	60/60.0
3	46/7.4	7/7.0

<sup>a</sup> Values are mean (SD) unless otherwise indicated. BMI=body mass index (kg/m<sup>2</sup>), ASA=American Society of Anesthesiologists.



**Figure 2.**

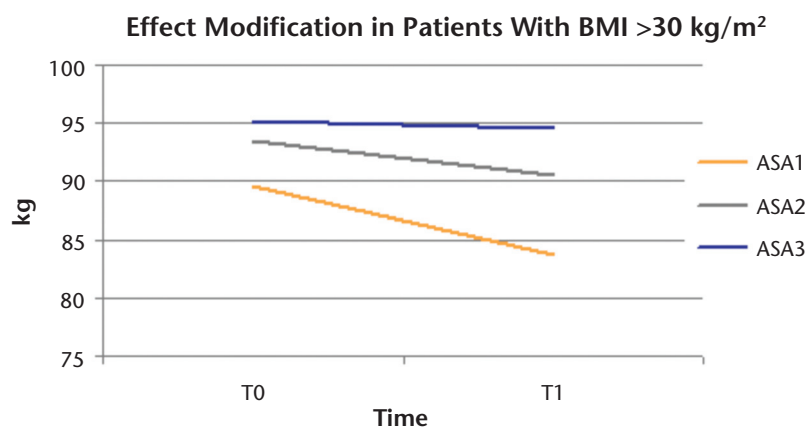
Body weight changes 1 year after total hip arthroplasty. \*Significant change compared with baseline ( $P < .05$ ); shown are mean and standard error. BMI=body mass index (kg/m<sup>2</sup>).

[CI]=0.1 to 1.4), which corresponds to a 1.1% weight gain; a significant decrease in body weight of 0.8 kg (95% CI=−1.2 to −0.3) in the group with overweight, which corresponds to a 1.0% weight loss; and a significant decrease in body weight of 3.2 kg (95% CI=−4.2 to −2.2) in the group with obesity, which corresponds to a 3.4% weight loss. The GEE analysis showed no confounding or effect modification by sex,

other knee or hip surgery, or age at the time of surgery for the change of body weight in time (data not shown).

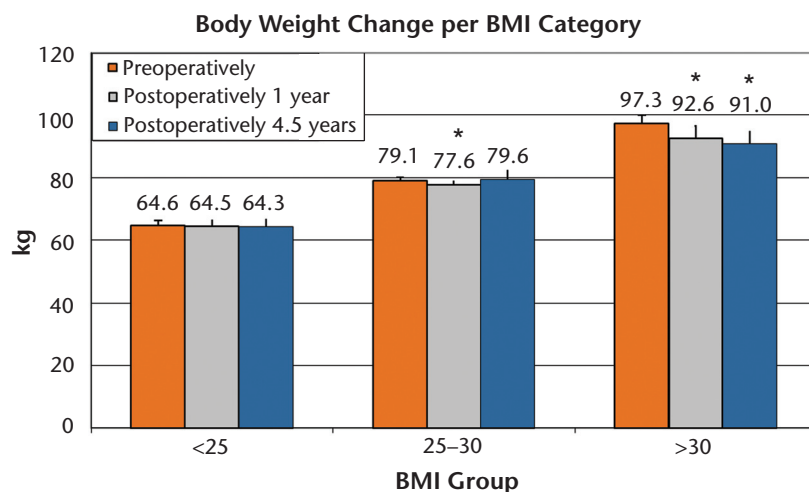
The ASA score did not affect the change of body weight over time (no confounding or effect modification) for any patients except those who were obese and had an ASA score of 3. In this particular group, no confounding was shown, but effect





**Figure 3.**

Effect modification of American Society of Anesthesiologists (ASA) score for patients with body mass index (BMI) of  $>30 \text{ kg/m}^2$  1 year postoperatively. T0=time of surgery, T1=1 year after surgery.



**Figure 4.**

Body weight changes 1 and 4.5 years after total hip arthroplasty. \*Significant change compared with baseline ( $P<.05$ ); shown are mean and standard error. BMI=body mass index ( $\text{kg/m}^2$ ).

modification was significant (95% CI=2.2 to 8.2), resulting in a smaller decrease in body weight compared with patients with an ASA score of 1 who were obese (Fig. 3).

### Long-term Effect of THA on Body Weight

Figure 4 shows the mean ( $\pm$  standard error) body weight of patients preoperatively and 1 year and 4.5 years postoperatively by BMI category. The GEE analysis of the long-term effect of THA on body weight

showed no change in body weight in the group of patients who were of normal weight and the group of patients who were overweight, but a significant decrease of 6.2 kg of body weight for those patients who were obese (95% CI=−9.0 to −3.5), which corresponds to a 6.4% weight loss. The GEE analysis showed no confounding or effect modification by sex or age at the time of surgery for the change of body weight over time (data not shown).

The ASA score did not affect the change of body weight over time (no confounding or effect modification) for any patients except those who had a normal weight and an ASA score of 3. In this particular group, no confounding was shown, but effect modification was significant (95% CI=−8.2 to −2.4), resulting in a prominent decrease in body weight compared with those who had a normal weight and an ASA score of 1 (Fig. 5).

### Discussion

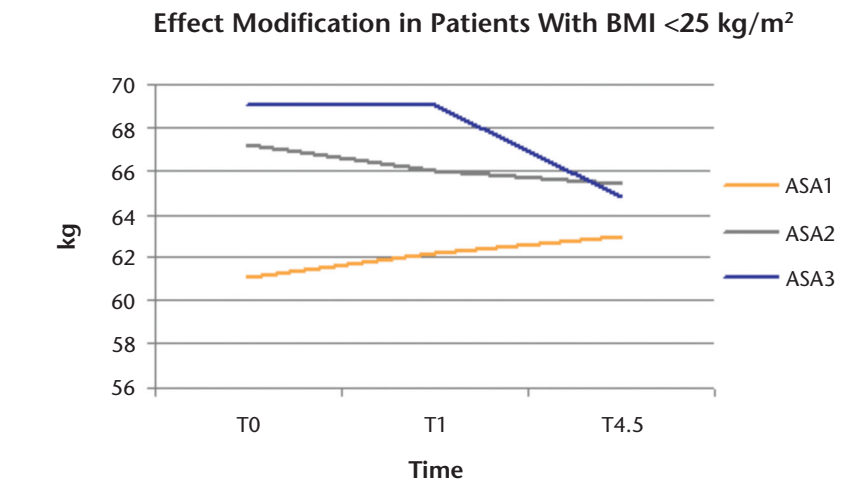
The results of this study showed that 1 year (short term) as well as 4.5 years (long term) after THA, there was no (5%) clinically relevant reduction in body weight compared with preoperative body weight, except for patients with obesity in the long-term group. In addition, body weight change was influenced by an ASA 3 status, which led to a more apparent decrease after 1 year in patients who were obese compared with patients with an ASA 1 status who were obese. The same pattern in body weight was seen in patients with normal weight and an ASA 3 status in the long-term group compared with patients with an ASA 1 status who were of normal weight.

The results of our study are in line with existing literature about weight change after THA surgery, which shows an increase or no change at all.<sup>12,18–21</sup> Although weight reductions were found in our research, they were small and considered not clinically relevant, with the exception of the patients with obesity in the long-term follow-up group. This latter finding is not seen in the study by Dowsey et al,<sup>20</sup> which categorized a study population of 471 patients into non-obese (BMI  $<30 \text{ kg/m}^2$ ), obese (BMI  $30–40 \text{ kg/m}^2$ ), and morbidly obese (BMI  $>40 \text{ kg/m}^2$ ) groups. In that study, the obese group gained 0.7 kg

in 1 year, whereas in our study, the obese group lost 3.2 kg in 1 year. The proportion of men and women in the Dowsey et al study sample was comparable to ours; therefore, it provides no explanation for the differences in results. The contradictions in weight change in both studies could be explained by the different numbers of patients who were morbidly obese and the way they were categorized. In our study, the percentage of patients who were morbidly obese was only 1.6%, so we did not categorize this specific group separately, whereas in the Dowsey et al study, 8% were morbidly obese. Vincent and colleagues stated that patients who are morbidly obese need far more time and effort for rehabilitation and subsequently to achieve physical improvements than patients who have less body mass,<sup>27</sup> which can have an effect on losing weight.

Aderinto et al<sup>19</sup> examined a long-term (3-year) effect of THA surgery on body weight change. They categorized their study group of 140 patients into nonobese (BMI <30 kg/m<sup>2</sup>) and obese (BMI ≥30 kg/m<sup>2</sup>) groups. Their obese group (n=59) showed an increase in body weight of 4 kg in 3 years. Again, this finding is in sharp contrast to our results of losing 6 kg after 4.5 years in the obese group (n=31). Cultural, sex (in Aderinto and colleagues' study, 55% were women; in our study, 67% were women), and group size differences aside, we have no explanation for this contrast.

In a study by Middleton and Boardman,<sup>12</sup> all patients had an increase in body weight, unlike the outcomes of our study. Middleton and Boardman examined the change of BMI, instead of body weight, 2 years after a THA surgery. It was not stated clearly, however, what had been the indication for surgery (OA, fracture, or other reasons) or whether there



**Figure 5.**

Effect modification of American Society of Anesthesiologists (ASA) score for patients with body mass index (BMI) of <25 kg/m<sup>2</sup> 4.5 years postoperatively. T0=time of surgery, T1=1 year after surgery, T4.5=4.5 years after surgery.

were comorbidities at the time of surgery, both of which could influence the outcome of the hip arthroplasty and subsequently a possible change in weight.

The finding in our study that sex and age at the time of surgery were not confounders or effect modifiers is in agreement with the findings of Aderinto et al<sup>19</sup> and Dowsey et al.<sup>20</sup> They showed that neither age nor sex predicted weight change after a primary THA. However, Dowsey et al concluded that comorbidities had no association with weight change after a primary THA either. This finding is in contrast to our finding that patients with a preoperative ASA score of 3, indicating severe systemic disease, presented a different course of weight change than patients with normal weight and obesity. For patients who were obese, the smaller decrease in body weight was not unexpected, as being obese and having severe systemic disease at the same time probably makes losing weight more difficult. In the patients who were of normal weight, there was a decrease in body weight, which was not expected and certainly not aimed for in this subcate-

gory. An explanation of this difference in outcome between our study and the study by Dowsey et al may lie in how comorbidities were measured and defined. Dowsey et al categorized the comorbidities as diabetic, cardiovascular, or respiratory types.<sup>20</sup> No information about the severity of these comorbidities at the time of surgery was provided. More research would be advisable, especially among patients of normal weight and comorbidities at the time of surgery, to gain insight into determinants of this phenomenon and to avoid undesirable weight loss.

### Strengths and Limitations

The large study group and the long-term follow-up of 4.5 years were major strengths of this study. Because of the difficulties in explaining why weight gain or weight loss occur in this type of research, we also consider it a strength to have taken the baseline BMI and comorbidities into account when analyzing our results. Another strength was the sourcing of patients from 3 different types of hospitals, which limits the risk of selection bias and improves generalizability of results.



The most prominent limitation of the study was that height and weight—and thus BMI—were self-reported. This limitation probably leads to an underestimation of the problem, as it is known that people tend to underestimate their weight and overestimate their height.<sup>28</sup> This underestimation is a well-described phenomenon in populations with varying characteristics.<sup>29–31</sup> However, it also can be argued that despite the supposed underestimation of weight, this study showed that no clinically relevant changes in body weight occurred except in the long-term follow-up group of patients who were obese. This underestimation also could explain the differences found in the results of this study compared with other studies. Although not relevant clinically (with the exception of the obese group in the long term), the results of this study did show minor reductions in body weight in contrast to earlier studies, in which no changes at all or even increases were reported.<sup>12,18–21</sup> It should be mentioned, however, that only Dowsey et al<sup>20</sup> clearly described that a health professional measured weight and height. The other researchers reported that weight and height were recorded preoperatively, but did not describe how these data were collected.

A further limitation of this study is the fact that no information was available about the intensity and types of exercise or physical activity or the nutritional changes of the participants. The fact that this study was conducted in the Netherlands also can be considered as a limitation. In contrast to Western countries (eg, the United States), in the Netherlands walking and bicycling are widespread methods of transportation, even for people after a THA. This cultural aspect may limit the generalizability of the results.

Finally, it must be remarked that large standard deviations in body weight were evident in this study. This finding is illustrated by the fact that the obese subgroup followed over 4.5 years showed a higher baseline body weight (97.3 kg) compared with the entire obese group preoperatively (93.2 kg). However, the long-term follow-up subgroup was not significantly different regarding preoperative BMI categories compared with the larger group of patients followed up at 1 year. Moreover, if we consider the 93.2-kg baseline weight of the entire obese group (instead of the 97.3 kg recorded by the smaller subgroup of people with obesity followed long term), we can still see a decline in body weight in the long term and certainly no increase. Overall, it can be concluded that more research is needed to gain further insight into the long-term effect of THA on body weight.

### Conclusions

From the results of this study, it can be concluded that in the short term as well as long term, there is no clinically relevant reduction of weight after THA, except for patients who are obese in the long term. Consequently, it can be argued that both for the survival of the prosthesis and for general health gains, people after a THA should be encouraged to lose weight. From that perspective, it can be suggested that weight management should be included as a component of postoperative rehabilitation if the patient is overweight or obese. This suggestion is in line with the physical activity recommendations for older adults by the American College of Sports Medicine, which state that older adults suffering from chronic conditions should be encouraged to become physically active.<sup>32</sup> In these recommendations, it is argued that preventive as well as therapeutic recommendations should be integrated

into postoperative rehabilitation programs. As part of the postoperative rehabilitation process, both the orthopedic surgeon and the physical therapist can play an important role. The orthopedic surgeon can act as a powerful motivational figure in stimulating an active lifestyle.<sup>33,34</sup> As the physical therapist is in charge of the postoperative rehabilitation and most patients visit the therapist frequently, he or she can play a central role in stimulating an active lifestyle, possibly in cooperation with a dietitian to support weight reduction in patients after THA.

Dr Stevens and Dr van den Akker-Scheek provided concept/idea/research design. All authors provided writing. Ms Paans, Dr Wagenmakers, Dr van Beveren, and Dr van den Akker-Scheek provided data collection. Ms Paans provided data analysis. Ms Paans, Dr Stevens, and Dr van den Akker-Scheek provided project management. Dr Wagenmakers, Dr van Beveren, Dr van der Meer, Dr Bulstra, and Dr van den Akker-Scheek provided consultation (including review of manuscript before submission).

The study was approved and conducted in accordance with the regulations of the medical ethics boards of the participating hospitals.

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## **Changes in Body Weight After Total Hip Arthroplasty: Short-term and Long-term Effects**

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